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OPERATION MAINTAINING OF AUTOMOBILE FORCED DIESEL ENGINES WITH ENSURING OF FUNCTIONAL CONDITION OF THE LUBRICATION SYSTEM IN EXPLOITATION

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ABSTRACT

The efficiency improvement of car operation is the main task of the system for maintenance and repair of diesel engines, in particular by reducing the cost of current and major repairs of engines, which are the most expensive unit (up to 25%). The engine work reliability with the ensuring the minimization of friction between the mating parts and the removal of excess heat from the most loaded elements, the performance of oil and its characteristics at an established level during operation of vehicles. The regularities of the volume effect of oil in the crankcase of diesel engines on the intensity of changes in the technical condition of the engine and oil aging during the operation are investigated. The analytical dependences of the intensity of engine oil aging, changes in the technical condition of the cylinder-piston group and the crankshaft bearings of the engine on the volume of oil in the crankcase of forced engines are substantiated. The process of preventing the lubrication system has been improved by optimizing the volume of oil topped-up to compensate for its loss and leakage.

KEYWORDS: Forced Diesel Engines, Engine Oil, Oil Change Frequency & Oil Standard Values

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INTRODUCTION

Experience in the operation of road transport shows that the wear of vehicle parts accounts for more than 50% of all failures in a car (Fedotov, 2012). Internal combustion engines are characterized by failures associated with wear, primarily of piston rings and cylinder liners, connecting rod and crankshaft journals, liners, and often in engines there is a scuff of these friction pairs.

At present, such areas of research as tribology - the science of friction and wear, and tribotechnology - its technical application are developing intensively. The molecular-mechanical theory of friction and the fatigue theory of wear, the contact-hydrodynamic theory of solid lubrication are developing. The results of the development of these areas make it possible at the design stage to evaluate and predict the durability of friction units.

The current trend in engine development is to increase the aggregate power, mainly in various ways of boosting. One of the most effective and common methods of forcing is to blow air into the engine cylinders, allowing you to increase power by two to three times and reduce specific fuel consumption. The consequence of this is to increase the mechanical and thermal stress of engine parts. Therefore, increasing the crankshaft speed is limited by the growth of inertial loads on the parts and the difficulty of lubricating friction pairs. Lubrication conditions deteriorate further with increasing rigidity of diesel engines and, accordingly, the load on the parts.

Modern forced automobile engines have, as a rule, a V-shaped arrangement of cylinders, which increases the load on the connecting rod bearings.

Forcing engines is accompanied by an improvement in their mass and overall performance. At the same time, the amount of engine power per unit of oil in the crankcase increases significantly, which leads to an increase in the temperature of the oil in the crankcase and an increase in oil consumption for waste.

Forcing also increases the oil pressure in the crankshaft bearings by two times, in conjunction "ring - sleeve" - up to three times, the temperature in the upper piston groove reaches 280 ºC, connecting rod inserts - 160 ºC, bearing turbo compressor - 280 - 320 ºC(Kuzmin, Borissov, 2012;Fedotov, 2012). All this significantly worsens the working conditions of the oil - its life is reduced due to faster response of the additives, oil consumption increases, the lacquer and carbon deposits on the surfaces of the parts are formed, and the ingress of solid particles into friction pairs leads to increased wear of the parts.

One of the ways to improve the efficiency of car operation is to improve the maintenance system and P to ensure and maintain in operation the required reliability indicators and reduce the cost of maintaining engine performance. The constant growth of requirements for improving the efficiency of car operation leads to the forcing of engines, which, in turn, is the cause of increased thermal stress of parts, deterioration of engine oil working conditions, increased carbon loss, accelerated additive response, increased wear rate of friction pairs, varnish and carbon formation, which reduces engine life.

The engines’ performance depends largely on the proper functioning of the lubrication system or its functional state. A functional condition is a condition in which it is able to perform its main function - to minimize the wear of mating parts due to the normalization of friction modes between them, and also to exclude thermal deformations of the most loaded elements by removing excess heat from them.

Maintaining the required level of oil in the engine’s crankcase is designed to provide the necessary temperature regime of engine parts, removal of wear products from friction pairs, as well as optimal lubrication conditions due to the additive package present in the oil. In operation there is a decrease of oil volume in the crankcase due to leaks and carbon loss, as well as a change in its properties due to aging. This leads to a violation of the functional condition of the lubrication system, an increase of oil temperature, a disruption of normal mode of lubrication and an intensification of parts’ wear(Kuzmin, Borissov, 2012).

The performing of periodic preventive maintenance of the lubrication system (for example, topping up the oil to the required level) allows restoring its functional condition, reducing of oil temperature, and updating the additives, which, in general, will increase engine life.

However, nowadays, the parameters of the topping up mode (frequency and volume) of engine oil in forced automotive diesel engines are not sufficiently scientifically substantiated, and a significant number of such engines are continuously operated with an unsustainable amount of oil, which leads to resource reduction.

Thus, researches aimed at improving of operation efficiency of forced automobile engines by maintaining the functional condition of lubrication system in operation are relevant.

METHODS

For an experimental assessment of indicators' changes of engine oil condition during the operation, monitoring of 28 KAMAZ-EURO vehicles for three years was organized at JSC Yugtransgaz Department of Technological Transport. Analysis of oil samples was carried out across 2 thousand kilometers of oil mileage. Total, more than 180 oil samples of 1.5 liters each were analyzed.

Shell Rimula R3 X SAE 15W40 oil was used. When analyzing oil samples, we determined: a kinematic viscosity, cSt, flash point in an open crucible, density for 20°C g/dm^3, contamination, cm-1, base number, mg KOH / g oil, density at 20 ° C, g / dm3, mass fraction of water, %. Parameters were determined in the laboratory according to GOST(Ostrikov, Nosov, 2010).

To assess the impact of topping up volume, all entire volume of the observed cars (28 vehicles) was divided into four groups depending on the average volume of oil topping. In the first group, the volume of oil topped up at one time was from 1.5 to 3.5 liters; in the second - from 3.5 to 5.5 liters; in the third - from 5.5 to 7.5 liters; in the fourth - from 7.5 to 10 liters.

In each group, the average oil temperature in the crankcase was recorded for the flight, oil consumption for burning and pressure in the lubrication system. To measure the temperature, a thermometer was used, which was installed in place of the oil dipstick. The oil pressure was determined by the vehicle's standard gauge on the instrument panel of the car. Oil consumption was determined by topping up to the top mark on the dipstick(Fedotov, 2012; Yakunin, 2003).

RESULTS

Processing the data on topping up the oil in cars of the controlled lot made it possible to obtain the distribution of the volume of topped up oil (Figure 1) and determine its parameters (Table 1).

Table 1: Parameters of the Distribution of the Volume Topped Up Oil

Indicators	Average Value	Coefficient of Variation
Volume of one-time topping up, liter	3,6	0,292
Specific topping, liter / 1000 Km	1,78	0,289

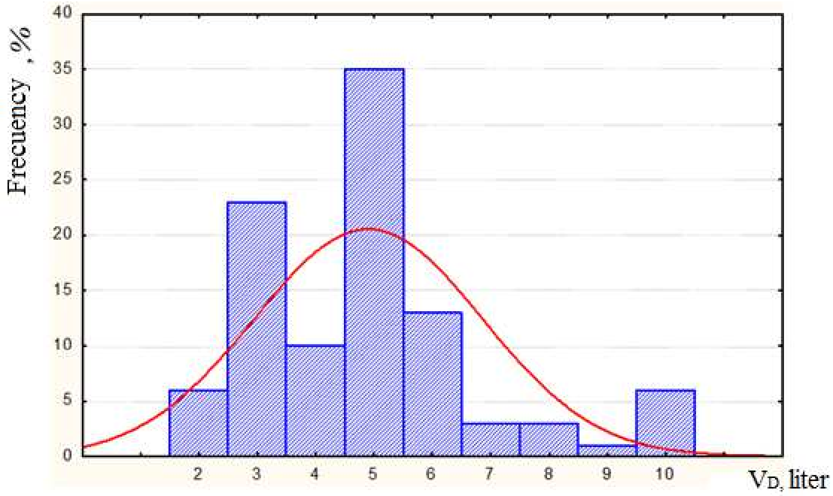

Figure 1: The Distribution of the Volume Topped Up Oil to Compensate for the Loss

From table 1 it can be seen that the volume and frequency of topping up the oil is twice as high as the recommended (Biniyazov, Denisov, 2017; Kuzmin, Borissov, 2012) values. In addition to the frequency of topping up the oil, the volume of oil added also affects engine reliability.

Both underfilling (low oil level in the crankcase) and oil overflow (high oil level in the crankcase) increase the wear rate of the parts. Using the method given in the third section, we determined the parameters of the effect of the volume of oil. The results of processing the experimental data are shown in Figures 2-5, and the dependency parameters are shown in Table 2.

The intensity of aging of the oil was determined taking into account changes in the viscosity and concentration of the alkaline additive during the operation of the oil for its service life in the vehicles of each group according to the conditions of the oil topping up.

Figures 2-5 show the main dependencies of oil parameters on the level in the engine crankcase obtained during the research.

It has been established that with an increase in single volumes of oil topping up, but more rare, the oil temperature increases up to 13-14 °C, which is explained by a smaller amount of oil in the engine crankcase, and, accordingly, its lower overall thermal conductivity. This causes a corresponding increase in the intensity of change of the technical state engine (by pressure change in the lubrication system –up to 40-44%) and oil aging intensity –up to 75-80%.

In the case when the one-time volume of oil to be added is smaller, but the refilling is carried out more often, the total oil volume is close to the maximum required level, which gives greater thermal conductivity and lower oil temperature and, as a result, a decrease in the intensity of changes in oil parameters and engine technical condition.

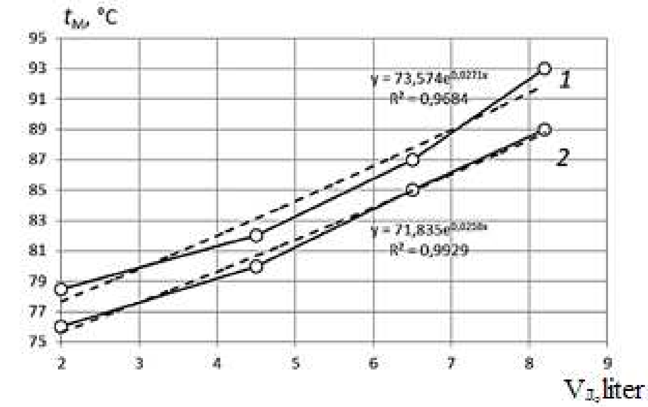

Figure 2: The Dependence of the Oil Temperature in the Engine Crankcase in Summer - 1 and In Winter - 2 On the Volume of One-Time Topping Up

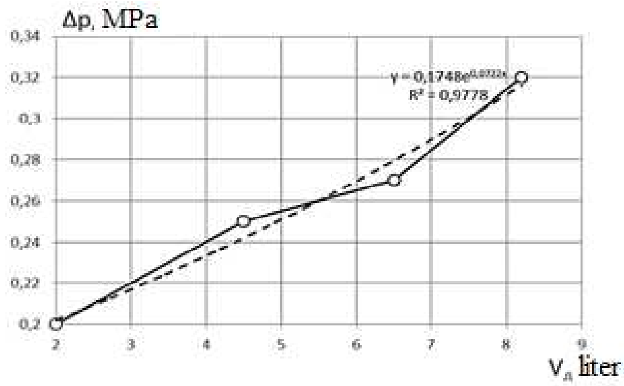

Figure 3: The Dependence of the Pressure in the Engine Lubrication System for Three Years of Operation of the Volume of a Single Oil Topping Up

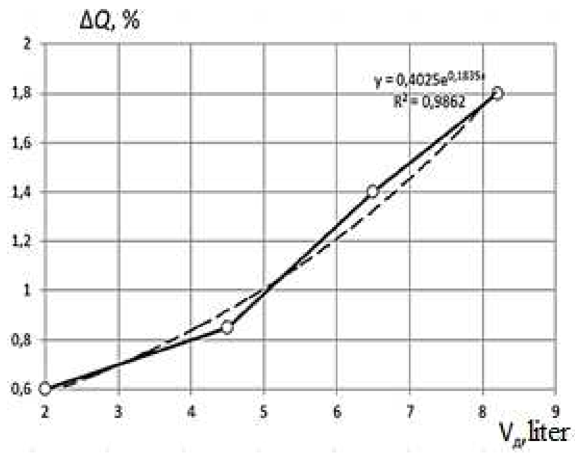

Figure 4: The Dependence of the Increase in Oil Consumption for Waste in the Engine for Three Years of Operation of the Volume of One-Time Topping Up Oil

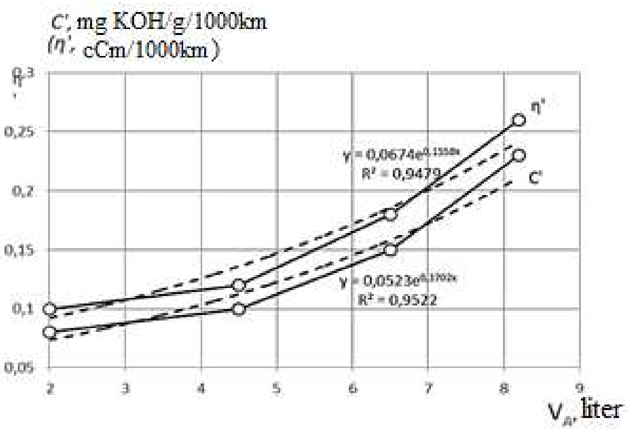

Figure 5: The Dependence of the Intensity of Reducing Viscosity η and Alkalinity C Oil from the Volume of One-Time Topping Up Oil

Table 2: Parameters of the Exponential Dependence of the Oil State Indicators Y on the Volume of a Single Oil Topping V_∂ ($Y=Ae^{bV\partial}$)

Oil Condition Indicator	*A*	*b*	R^2
The temperature in the crankcase in summer, °C	73,574	0,0271	0,968
The temperature in the crankcase in winter, °C	71,835	0,0258	0,953
System pressure reduction, MPa	0,175	0,0722	0,978
The intensity of the reduction of oil viscosity, cCm/1000 km	0,0674	0,1558	0,948
The intensity of the reduction of alkalinity, mg KOH/g/1000 km	0,0523	0,1702	0,952

R^2 - is the parameter of reliability of the trend line to the experimental data

The main recommendation of this research is to maintain the functional condition of the lubrication system due to the optimal parameters (volume and frequency) of the oil topping up mode.

Taking into account the above factors, with the prevailing income rate for KAMAZ-EURO vehicles, the specific operating costs for topping up the oil and for eliminating failures due to the lubrication system, which are shown in figure 6(Johnson, 1996; Krause, 1971). The optimum operating time before topping up the oil is 1 thousand km. For the life of oil, it is advisable to make topping up oil for 17 times in a volume of 1.8 - 2 liters.

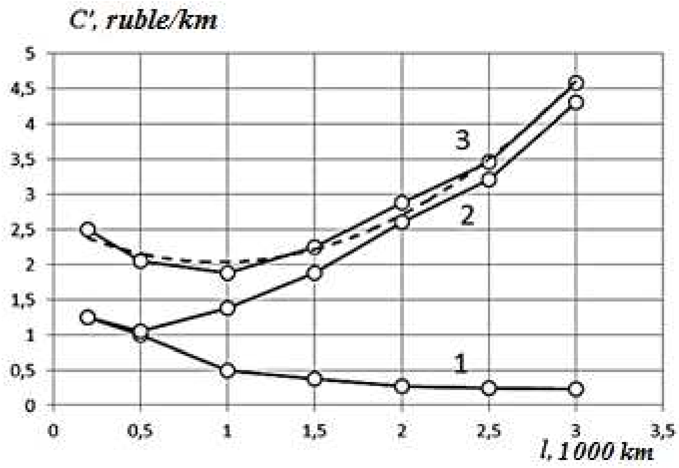

Figure 6: The Dependence of the Specific Operating Costs for Topping Up the Oil –1, for Maintenance - 2 and Total - 3 on the Frequency of Oil Topping Up

Based on the obtained results, the minimum level will be ensured: oil temperature of the crankcase, the intensity of changes in the technical condition of the engine and the intensity of oil aging. Consequently, under these conditions of topping up and the engine and oil life will be maximized.

CONCLUSIONS

To ensure the proposed oil topping up mode, an oil level regulator was developed for internal combustion engines (Figure 7).

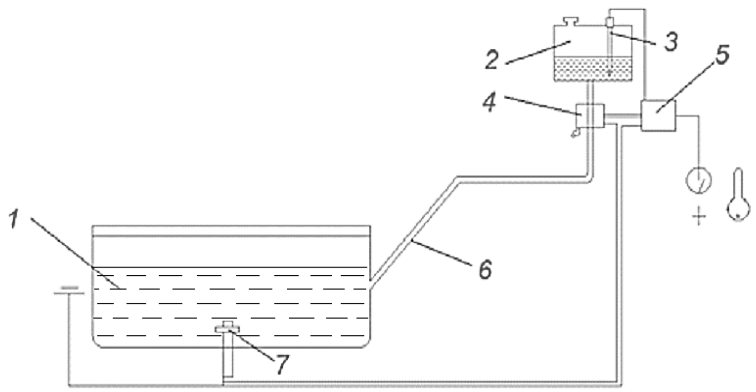

Figure 7: Scheme of Oil Level Regulator in the Crankcase of the Engine (According to Patent No. 2641184): 1 - Oil Crankcase; 2 - Tank; 3 - Oil Level Indicator in the Tank; 4 - Valve; 5 – Switch Off; 6 - Flexible Oil Pipe; 7 - Crankcase Oil Level Sensor

It was received a patent for invention № 2641184. Oil level regulator is an element of the functional tuning of a car, performed at the request of persons operating these cars. Oil level regulator prototypes are installed on three vehicles of the controlled lot and are being tested in the reference farm.

The principle of oil level regulator operation is as follows: the control system is turned on by the driver with the switch off 5 when the engine is not running and is stationary. When the oil level drops below the upper mark on the dipstick, sensor 7 sends a signal to valve 4, which opens and oil from tank 2 enters the crankcase 1. When the oil reaches the upper mark of the dipstick, the sensor 4 closes and the oil supply to engine crankcase stops. When oil finishes in the tank the indicator 3 informs the driver about the need to add oil to the tank.

Oil level regulator using allows you to avoid the engine when the oil level in the crankcase is outside the marks on the oil dipstick, which reduces the likelihood of accidental damage to the crankshaft bearings and the cylinder-piston group of the engine. An alternative to RUM is oil topping up after 1,000 km of the car's run no higher than the top mark on the dipstick.

When assessment the economic efficiency of the application of the research's results, the costs of maintaining of functional condition of the lubrication system were compared with the existing and proposed optimal mode of topping up the oil in the crankcase. Thus, nowadays, the refilling is carried out through 2000 km with an average unit cost of 1,48 times higher than at the proposed frequency of replenishment.

6. CONCLUSIONS

A detailed methodology of both the transmission and braking system have been studied and presented, with their reasoning of using materials for the chassis and axle. The entire process of design has been done theoretically, and testing has been done at Budh International Circuit, Delhi through the ISIE, Indian Kart Racing Event 2K17. And, the validation of the complete Transmission and braking system was completely done, and regarding the basis of present go-kart, there can be better developments done in future.

REFERENCES

1. *Biniyazov A.M., Denisov A.S. Improving the prevention of lubrication system of KAMAZ-EURO forced autotractor diesel engines. Scientific journal "New of Kazakhstan Science", Almaty, 2017,1,pp. 136-152.*
2. *Kuzmin N.A., Borissov G.V. The scientific basis of the processes of changing the technical condition of cars. N. Novgorod: NSTU, 2012,270 p.*
3. *Ostrikov V.V., Nosov A.O. Theoretical prerequisites for choosing the method of oil cleaning engine from pollution. Scientific Review, 2010, 2, pp. 33-34.*
4. *Fedotov A.I. Car diagnostics. Textbook for universities. Irkutsk: Publishing House STU, 2012, 468 p.*
5. *Yakunin N.N. Methodological basis for monitoring and managing the technical condition of vehicles in operation. Moscow:Engineering-1, 2003, 178 p.*
6. *Johnson G. Failure of components. Automobile Engineers, March, 1996, pp. 108-111.*
7. *Krause H.R. Tribomechanical Reaction in the Friction and Wearing Process of Iron. Wear, vol.18,3,1971, 403-412.*